

Appendix D: Northern long-eared bat and prey analysis for ammonia and cadmium.

1.1 Northern Long-Eared Bat (*Myotis septentrionalis*)

1.1.1 Northern Long-Eared Bat Ammonia Effects Assessment: Freshwater

EPA's BE for the Northern long-eared bat focuses below on the effects that the ammonia criteria could cause due to ingesting potentially contaminated prey. Because the bats do not live in the water, EPA concludes there will be no effects as a result of meaningful residential exposure.

Bats consume some combination of terrestrial and aquatic insects. Studies indicate that the Northern long-eared bat (*Myotis septentrionalis*) prefers terrestrial over aquatic insects and prefers to forage in woodland over riparian areas when available (Sparks et al 2005, USEPA 2016). Lepidopterans and Coleopterans (beetles), primarily terrestrial species, make up the majority of the diet of the Northern long-eared bat (Brack and Whitaker 2001, Feldhammer et al 2009, Lee and McCracken 2004, Whitaker 2004).

The Northern long-eared bat relies in part on emergent aquatic insects as a dietary resource and may be affected if ammonia, at water column concentrations specified by the acute or chronic criteria magnitude and duration, were to adversely affect a large portion of emergent aquatic insects. However, aquatic life criteria are based on the fifth centile of sensitive genera to ensure the broad aquatic community, including emerging aquatic insects, are adequately protected. Aquatic insects ranked among the most tolerant taxa to acute ammonia exposures (Table 1). The data suggest that emergent insects will not be affected by the acute criteria, which are between 1-2 orders of magnitude below the species' GMAVs.

Chronic toxicity data related to emergent aquatic insects were relatively limited; however, an insect represented the most tolerant genus to chronic ammonia exposures (*Pteronarcella* genus mean chronic value [GMCV] = 73.74 mg/L, normalized to pH 7 and 20°C).

In addition to emergent aquatic insects, the Northern long-eared bat also relies heavily on terrestrial insects as a primary food source. In general, a number of studies indicate that terrestrial insects make up a greater percentage of the bat's diet, depending on the location (USFWS 1999, USEPA 2016). Terrestrial insects will not be affected at all by the new criteria.

Table 1. Acute insect toxicity data used to derive the acute ammonia criterion. Note, 69 GMAVs were available to derive the acute criterion, with insects ranking among the least sensitive taxa.

Genus	Genus Mean Acute Value (mg/L) ^a	Genus Rank in SSD
<i>Erythromma</i> (insect)	2,515	69
<i>Philarctus</i> (caddisfly)	994.5	68
<i>Stenelmis</i> (beetle)	735.9	67

<i>Chironomus</i> (midge)	681.8	65
<i>Drunella</i> (mayfly)	442.4	64
<i>Callibaetis</i> (mayfly)	246.5	60
<i>Pachydiplax</i> (dragonfly)	233.0	59
<i>Skwala</i> (stonefly)	192.4	52
<i>Enallagma</i> (damselfly)	164.0	47

^a Normalized to pH 7 and 20°C (USEPA 2013).

Bats may also ingest ammonia through drinking water; however, this is not considered to be a meaningful route of exposure to elicit adverse effects in bats because the ammonia criteria are based on water-column exposures where the most sensitive route of exposure occurs at the gills, which does not apply to terrestrial species. Adverse effects typically result from an imbalance between internal and external ammonia concentrations. Ammonia is produced naturally in internal tissues, and organisms have natural mechanisms for excreting ammonia. Ammonia ingested by bats will be excreted through natural mechanisms (e.g., urine). Ammonia becomes toxic when the surrounding environment contains a high enough level that excretion mechanisms must work against a gradient that results in the organism being unable to excrete the excess ammonia (EPA 2013). This situation does not apply to terrestrial species which are not surrounded by environmental ammonia.

Therefore, because criteria are implemented conservatively, derived to protect the broad aquatic community (including emergent insects), and the bat's prey items are insensitive to ammonia, EPA's approval of Maine's acute and chronic freshwater ammonia standards may affect, but is Not Likely to Adversely Affect (NLAA), the Northern long-eared bat through effects on its prey or ingesting drinking water. As such, the effects of approval of the freshwater ammonia water quality standards are too small to be detected and thus any effects from ingesting prey or drinking water to the bat are insignificant.

2.1.1 Northern Long-Eared Bat (*Myotis septentrionalis*)

2.1.1 Northern Long-Eared Bat Cadmium Effects Assessment: Freshwater

EPA's BE for the Northern long-eared bat focuses below on the effects that the cadmium criteria could cause due to ingesting potentially contaminated prey and drinking water. Because the bats do not live in the water, EPA concludes there will be no effects as a result of meaningful residential exposure.

Bats consume some combination of terrestrial and aquatic insects. Studies indicate that the Northern long-eared bat (*Myotis septentrionalis*) prefers terrestrial over aquatic insects and prefers to forage in woodland over riparian areas when available (Sparks et al 2005, USEPA 2016). Lepidopterans and Coleopterans (beetles), primarily terrestrial species, make up the majority of the diet of the Northern long-eared bat (Brack and Whitaker 2001, Feldhammer et al 2009, Lee and McCracken 2004, Whitaker 2004).

The Northern long-eared bat relies in part on emergent aquatic insects as a dietary resource and may be affected if cadmium, at water column concentrations specified by the freshwater acute or chronic criteria magnitude and duration, were to adversely affect a large portion of emergent aquatic insects. However, aquatic life criteria are based on the fifth centile of sensitive genera to ensure the broad aquatic community, including emergent aquatic insects, are adequately protected. Aquatic invertebrates tend to store cadmium in a detoxified state in their body tissues (USEPA 2016), which effectively reduces the toxicity of the cadmium bats ingest with contaminated prey. Aquatic insects are ranked among the most tolerant taxa to acute cadmium exposures (Table 2). The data suggest that emergent insects will not be affected by the acute criteria, which are between 2-5 orders of magnitude below the species' GMAVs.

Table 2. Acute insect toxicity data used to derive the acute freshwater cadmium criterion.

Genus	Genus Mean Acute Value (µg/L) ^{ab}	Genus Rank in Species Sensitivity Distribution (SSD)
<i>Chironomus</i> (midge)	49,052	75
<i>Rhithrogena</i> (mayfly)	22,138	71
<i>Sweltsa</i> (stonefly)	>20,132	70
<i>Hexagenia</i> (mayfly)	7,798	63
<i>Ephemerella</i> (mayfly)	4,467	53
<i>Arctopsyche</i> (caddisfly)	>1,637	45
<i>Baetis</i> (mayfly)	350.4	32

^a Normalized to a hardness of 100 mg/L, expressed as total cadmium (corresponding acute criterion magnitude = 1.9 µg/L total cadmium).

^b 75 GMAVs were available to derive the acute criterion, with insects ranking among the least sensitive taxa.

Chronic toxicity data related to emergent aquatic insects were relatively limited; however, a midge ranked fourth most sensitive to chronic exposures (*Chironomus* GMCV = 2.0 µg/L total cadmium, normalized to hardness of 100 mg/L) (USEPA 2016). The midge GMCV (based on the 20% effects level, or EC₂₀) is greater than the corresponding chronic criterion magnitude (0.79 µg/L total Cd, hardness = 100 mg/L),”and a large portion of individuals (i.e., > 80%) are not anticipated to be affected if cadmium concentrations were hypothetically at the chronic criteria magnitude for extended time periods consistent with chronic toxicity tests (e.g., 28-60 days) in Maine freshwaters (which is not the anticipated effect of the criteria). Further, the midge chronic toxicity value was based on exposure durations that were significantly longer than the 4-day chronic criterion duration.

Consequently, aquatic macroinvertebrate populations should not be adversely affected by cadmium at criteria levels.

In addition to emergent aquatic insects, the Northern long-eared bat also relies heavily on terrestrial insects as a primary food source. In general, a number of studies indicate that terrestrial insects make up a greater percentage of the bat's diet, depending on the location (USFWS 1999, USEPA 2016). Terrestrial insects will not be affected at all by the new criteria.

Bats may also ingest cadmium through the water they drink. Aquatic organisms are considered to be more sensitive to cadmium relative to birds and mammals (USEPA 2016), and birds and mammals are considered to be comparatively resistant to cadmium. Consequently, criteria that are protective of aquatic life are also considered to be protective of mammals and birds (including aquatic-dependent wildlife).

Based on the analysis above and because criteria are implemented conservatively and derived to protect the broad aquatic community (including emergent insects), EPA's approval of Maine's acute and chronic freshwater cadmium standards may affect, but is Not Likely to Adversely Affect (NLAA) the Northern long-eared bat through its prey or ingesting drinking water. As such, the effects of approval of the freshwater cadmium water quality standards are too small to be detected and thus any effects from ingesting prey or drinking water to the bat are insignificant.